# Oxidative Changes of Lipids during Microwave Heating of Minced Fish Flesh in Catering

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**Abstract**: The influence of microwave heating (microwave oven Electrolux, 2450 MHz, 400 W) from 8 up to 24 min on the oxidation and fatty acid composition of lipids of common carp (*Cyprinus carpio*) and Atlantic mackerel (*Scomber scombrus*) minced fish flesh were studied. The heating treatment at all conditions reduced moisture and therefore, increased lipid and dry matter contents. The isolated lipids were subjected to the following analyses: peroxide value, acid value and content of conjugated dienes (by absorbance at 232 nm). The free fatty acid content in the lipid fraction of the fish flesh was significantly reduced by cooking. Conjugated diene levels in fish muscle increased and peroxide values decreased for all cooked samples. Changes in fatty acids composition were only small.

**Keywords**: acid value; common carp; conjugated dienes; fatty acids; fish lipids; lipid oxidation; mackerel; microwave heating; peroxide value

## INTRODUCTION

During cooking of fish products, chemical and physical reactions take place that improve or impair their nutritional value. Cooking induces water loss in the food, but in turn increases its lipid content in most cases and only some fat is lost in the case of the oiliest fish. Moreover, this effect is also dependent on the type of cooking (Hearty *et al*. 2007; Sveinsdóttir *et al*. 2009).

Microwave heating is widely used because it is fast and convenient for food preparation with typical characteristics of colour, flavour, texture, and palatability. The fish flesh productions will take place especially in designed production kitchens related to catering, and hotel establishments (Sumnu 2001). The aim of this work was to study oxidative changes of lipids that occur under the influence of different cooking time during microwave heating for common carp (*Cyprinus carpio*) and Atlantic mackerel (*Scomber scombrus*) fishes in catering.

## MATERIAL AND METHODS

***Sample preparation and microwave heating.*** Fish were obtained from Czech retail (Tesco Prague) at the end of the year 2008. Fish was quickly transported to laboratory in an ice box. Head, scales, viscera and backbone were removed and two fillets were obtained from each resulting fish. The samples were homogenised, minced in a glass blender, and freshly packed. Samples (150.0 g ± 1.0 g) of each treatment were weighed in Pyrex Petri dishes of 14 cm diameter and 2 cm high, covered with a PVC "l ml thickness". The microwave oven (Electrolux, model EMM2005, 2450 MHz, manufactured by PRC) operated at 400 W. The samples were heated in the microwave oven in the centre of the rotating plate 27 cm in diameter for 8, 12, 16, 20, and 24 minutes. Two independent series of experiments were carried out under the same conditions. After each heating period, the microwave oven was stopped for 30 min in order to get cold before starting the next heating. All the

samples after lipids extraction by Folch method (Folch *et al.* 1957) were stored at –18°C till the analysis in sealed tubes.

***Analytical methods***. The following standard analytical methods of IUPAC (Paquot & Hautfenne 1987) were used; the acid value (Method 2.206) was determined by titration, and the results were expressed in mg KOH/g lipid; the peroxide value (Method 2.501) was determined iodometrically, and the results were expressed in meq/kg. Conjugated dienoic bonds were determined by ultraviolet spectrophotometry at 232 nm, and the results were converted into % using the coefficients suggested by IUPAC (Method 2.206). The moisture was determined by oven-drying at 105°C to a constant weight (AOAC 2005). The fatty acid composition was determined by gas chromatography (Method 2.302) after conversion into the respective methyl esters (Method 2.301). The results were expressed in % of areas of methyl ester peaks.

***Statistical methods***. The data were evaluated using the one-way ANOVA and the regression analysis. The software StatSoft, Inc. (USA) modified in STATISTICA-CZ (Software system for data analysis), Version 7.1 was used.

## RESULTS AND DISCUSSION

The fat content in the samples subjected to heating was relatively higher than that for the raw samples, which is probably due to the lower moisture content of the cooked fish. These are losses that do not lead to excessive drying out of the minced flesh. The dry matter content increased after cooking for both samples of minced fish flesh. (Data not shown to spare space.)

Heating of fresh minced common carp and mackerel fish flesh (Figure 1) brought a decrease in the peroxide value and acid value, even 2–3 fold, within the first minutes of heating. No increase in the peroxide value, even during 24 min microwave heating was not observed after 20 min of heating of common carp fish minced flesh a slight increase in acid value occurred, not reaching the initial level (Figure 2). In general, the total amount of above mentioned products did not increase as a result of heating, even for 24 minutes. The reason for this is probably that there was too little oxygen present during boiling for intensive oxidation processes to take place, especially considering that the internal temperature measured for the fillets, regardless of the cooking method or technique used, was never higher than 90°C, due to the large amount of water inherently present in the tested product. The hydroperoxides were decomposed due to higher temperature.

The rate of conjugated dienes formation (Figure 3) could be greater than the decomposition rate, leading to increase in conjugated dienes accumulated in the lipid fraction. Almost immediately after peroxides have been formed, the non-conjugated double bonds present in natural unsaturated lipids were converted to conjugated double bonds (Gunstone & Norris 1983). This is accompanied by increased UV absorption at 232 nm. It is an indicator of aut-oxidation and is reported to increase with uptake of oxygen and formation of peroxides, during the early stages of oxidation (Agren *et al.* 1993).

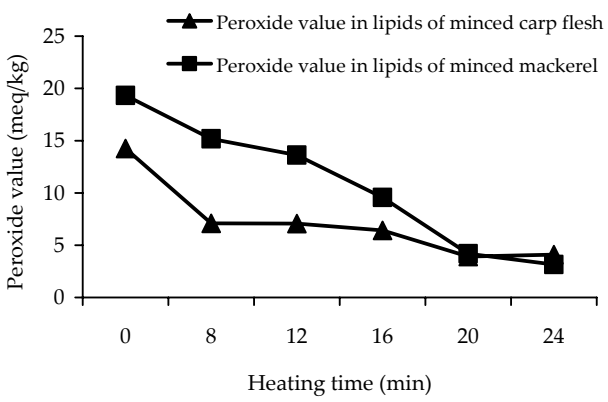


Figure 1. Changes in peroxide value of lipids during microwave heating of minced fresh common carp and mackerel fish

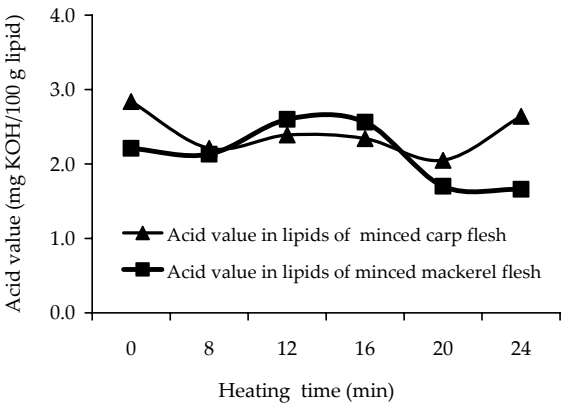


Figure 2. Changes in acid value of lipids during microwave heating of minced fresh common carp and mackerel fish

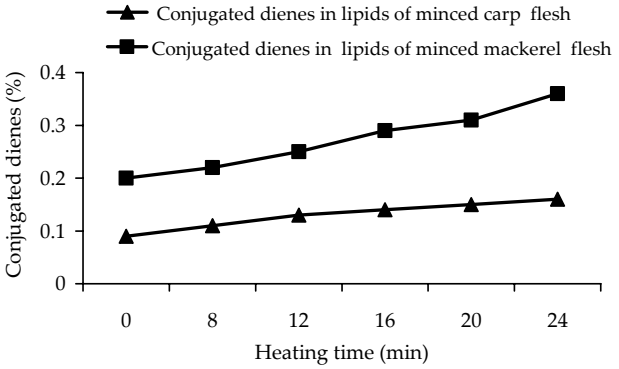


Figure 3. Changes in conjugated dienes of lipids during microwave heating of minced fresh common carp and mackerel fish

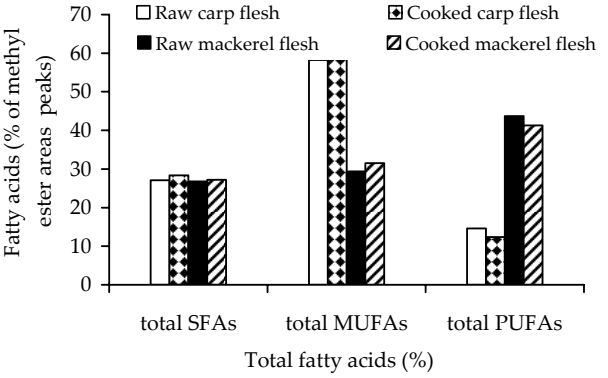


Figure 4. Fatty acid composition of lipids during microwave heating of raw minced fresh and cooked for 24 minutes

As evident from the Figure 4 the most abundant fatty acids found in raw common carp and mackerel minced flesh were palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1n-9c), linoleic acid (C18:2n-6c), linolenic acid (C18:3n-3), eicosapentaenoic acid (EPA) (20:5n-3) and docosohexaenoic acid DHA (C22:6n-3). However, mackerel minced flesh had higher levels of the n-3 polyunsaturated fatty acids, DHA (C22:6n-3) EPA (C20:5n-3). Microwave heating for 24 minutes affected the minced fish flesh, the observed changes were not similar for the different fatty acids because some fatty acids decreased, some increased, and others did not change. The observed changes must be a consequence of the water loss produced by these processes (Weber *et al*. 2008).

## CONCLUSIONS

During microwave heating of fresh minced fish flesh lipids contained in them were relatively stable with respect to oxidation; they were no hazard to health quality of fish products in catering establishments. Small changes in monounsaturated fatty acids and polyunsaturated fatty acids (n-3 and n-6) took place in minced flesh after 24 min of microwave heating, in both samples studied.

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